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ABSTRACT

Internal verbal processes were assumed to play a central role in complex school learning tasks. The research reported was concerned with a certain class of internal verbal behavior. The implicit associative response (IAR) was conceptualized as an internal verbal response that may occur when an individual sees or hears a word. Results of four experiments are given. The major purpose of experiments one, two, and four was to examine variables that may influence the frequency and nature of IAR's and to clarify the role of IAR's in learning and retention. Experiment three was designed to explore a second variable, the effects of instructions to pronounce words during learning on subsequent recognition performance. The subjects of the first two experiments were students at Northwestern University; children from prekindergarten through fourth grade were the subjects in the third and fourth experiments. Results indicated that associative encoding processes were modified by variation of the semantic context of the to-be-remembered word, that the perceived situational frequency of a word was critical in the recognition decision, that advance information had little effect on encoding but did affect the recognition-decision process, and that recognition performance was best when words were overtly pronounced. References are included. (Author/NH)

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VARIABLES AFFECTING FREQUENCY OF WORD-RECOGNITION ERRORS

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March 10, 1970

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SUMMARY

Internal verbal processes are assumed to play a central role in complex school learning tasks (e.g., reading). The research reported here is concerned with a certain class of internal verbal behavior. The implicit associative response or IAR is conceptualized as an internal verbal response that may occur when an individual sees or hears a word. For example, when the word "gallop" is encountered the word "horse" may be produced as an IAR. The IAR is presumed to be involved in verbal mediation, so is important both to the educator and to the theoretical psychologist.

A procedure recently developed for the study of IAR production is as follows: A long list of words is presented, and subjects are asked to indicate whenever a word appears that had occurred earlier in the list. Late in the list, words are inserted that are common associates of earlier appearing words. For example, "gallop" may appear early in the list and "horse" later. Under these conditions subjects are more likely to falsely recognize "horse" as having appeared earlier than they are control words not associated with any earlier appearing word. These errors have been interpreted to mean that when "gallop" was first presented "horse" was elicited as an IAR, resulting in the later confusion. This false recognition effect has been obtained with both adults and children, and the procedure appears to be a promising one for the study of implicit verbal processes.

This report describes the results of four experiments. The major purpose of Experiments I, II, and IV was to examine variables that may influence the frequency and nature of IARs and to clarify the role of IARs in learning and retention. Experiment III was designed to explore a second variable - the effects of instructions to pronounce words during learning on subsequent recognition performance.

In Experiment Ia, 35 words were presented either singly or in one of two sentence conditions. In one sentence condition either the to-be-remembered word or its most common associate (according to word association norms) fit sensibly within the sentence. In the other condition the to-be-remembered words fit sensibly but the associates did not. Subsequent false recognitions of these associates were less frequent in the latter condition than in the words - alone or in the first sentence condition. This difference between the two sentence conditions did not occur when, as in Experiment Ib, each to-be-remembered word was presented alone immediately prior to its presentation in the sentence. The results were interpreted in terms of the modification of associative encoding processes as a result of particular variations in the semantic context of a to-be-remembered word.

In Experiment II, a list of words was presented visually to 160 college students. The Ss were asked to indicate for each word whether or not it had appeared earlier on the list. Late in the list were associates of "critical stimulus" or CS words that had appeared earlier either one, three, five, or seven times. The frequency of false recognitions of

the associates first increased, then declined, as a function of the number of times their corresponding CS words had occurred, and was greater than that for nonassociates of previously appearing words. These results were considered in terms of a two-stage recognition model wherein the perceived situational frequency of a word is critical in the recognition decision.

Experiment III was concerned with children's adoption of error-reducing strategies in a recognition task when they have foreknowledge of the nature of that task. Information regarding the nature of IAR-produced false recognitions resulted in a reduction of such errors. That reduction was as great when the information was withheld until after the learning stage as it was when give prior to learning, suggesting that such advance information has little or no effect on encoding, but does affect the recognition-decision process.

The purpose of Experiment IV was to examine word recognition performance as a function of age and learning instructions with respect to pronunciation. Recognition performance was best when Ss had overtly pronounced the to-be-remembered words, and equal under conditions of covert pronouncing and no instructions to pronounce. No other differences were significant.

INTRODUCTION

There is evidence that when a single, familiar word is presented to an adult or school age child at least two types of implicit or internal responses may occur. One is the response involved in the act of perceiving the word. This implicit response has been called the representational response (RR) by Bousfield, Whitmarsh, and Danich (1958). The second is an implicit associative response (IAR) consisting of a word (or words) previously associated with the word presented and elicited as an IAR (Underwood, 1965).

A convincing demonstration of the occurrence of IARs, and certain consequences of such occurrence, was provided by Underwood (1965). A list of 200 words was presented to college students who were asked to report whenever they recognized a word that had appeared earlier in the list. Appearing late in the list were experimental words (E words) which were high frequency associates of certain words (critical stimulus or CS words) which had occurred earlier in the list. For example, the CS word ROUGH appeared early in the list and the E word SMOOTH appeared later. It was assumed that if the E words had been elicited previously as IARs by the CS words, subjects (Ss) frequently would incorrectly identify the E words as having appeared earlier in the list. This prediction was confirmed by Underwood in that for three of the five classes of words used, false recognition of E words was reliably more frequent than for control (C) words. Subsequent experiments both with adults (e.g., Kimble, 1968) and with children (e.g., Hall and Ware, 1968) have yielded results essentially in agreement with those of Underwood.

Presumably, IARs serve as links in implicit verbal chains assumed to mediate complex human behavior in school learning and problem solving situations. It seems probable, then that the frequency with which IARs are produced and the specific nature of the IARs are lawfully related to success in activities that involve reading, originality of productions, and problem solving. In addition, it has been assumed that IARs constitute one portion of the information that is encoded for memory during the learning of verbal material. That is, knowledge regarding IARs constitutes knowledge about fundamental processes in memory. Thus, it is important to examine variables which may influence both the frequency and the nature of IARs, and to clarify the role of IARs in learning and retention. These were the major objectives of a set of experiments completed by the author some eighteen months ago which were supported in part by a prior grant from the U.S. Office of Education (Hall, 1968). The four studies reported here constitute an extension and expansion of this program. In addition, Experiment III was designed to explore a second variable - the effects of instructions to pronounce words during learning (either overtly or covertly) on subsequent recognition performance by children at varying age levels. This experiment evolved from an earlier study (Hall, 1968) in which overt pronunciation, relative to no instructions to pronounce, facilitated subsequent recognition performance for kindergarten children but did not appear to have this effect for somewhat older children.

EXPERIMENT I: ASSOCIATIVE ENCODING OF WORDS IN SENTENCES*

It appears that, at least under certain conditions, the word association responses of individuals reflect associative processes active in the encoding of words for memory. This conclusion is supported by the results of word-recognition experiments in which strong associates of previously presented words are falsely recognized more frequently than are unrelated (control) words (see e.g., Underwood, 1965; Kimble, 1968). Presumably those strong associates had occurred earlier as implicit associative responses to the presented words and, in some fashion, were encoded along with the presented words, setting the stage for their subsequent false recognition.

The major purpose of the experiments reported here was to further clarify the nature of associative encoding by examining the effects of variations in the semantic context of words on these processes. In the recognition studies referred to above, the to-be-remembered words were presented singly, as is the case in words association testing. Thus, it is not surprising that normative word association data are indicative of the nature of the associations involved in the encoding of single words. But, are these data similarly indicative of the associations relevant to encoding when the to-be-remembered words are in the context of a meaningful sentence? The answer, it would seem, would depend on particular characteristics of that context. It was hypothesized that the probability of a particular associate being involved in the encoding of a word presented in a meaningful context, and thus occurring as an implicit associative response to that word, is related to the "semantic acceptability" of the associate in the particular context. Specifically, if the substitution of the associate for the to-be-remembered word preserves the meaningfulness of the sentence (although not necessarily the precise meaning), then that associate is likely to occur as an implicit associative response during the learning (encoding) process. However, if the context is such that a substitution of the associate would substantially reduce meaningfulness, the probability of that associate occurring as an implicit associative response is reduced correspondingly. Thus, the frequency of false recognitions of associates (using standard word association norms) would be lower under the latter than under the former condition. The present experiments were designed to examine this prediction.

Experiment Ia

In Experiment Ia a set of words was presented for learning either singly or in one of two sentence conditions. In one sentence condition

* The results of this experiment are described in an article of the same title by James W. Hall and Irene Crown, in press in the Journal of Verbal Learning and Verbal Behavior.

either the to-be-remembered word or its most frequent associate fit sensibly within the sentence, whereas in the other condition the to-be-remembered words fit sensibly but their associates did not. It was predicted that in the latter case a "semantic constraint" would be placed on the occurrence of the associates as implicit associative responses, and that this constraint would be reflected by a lower frequency of subsequent false recognitions of these associates.

Method

Subjects: The Ss were 68 students enrolled in an introductory psychology course at Northwestern University. Their participation in the experiment fulfilled a course requirement.

Design, Materials, and Procedures: The general design called for the tape recorded presentation of two lists of words to each S, the first under free-learning instructions, and the second under recognition-test instructions. Of the 35 words in List 1, 15 were words which appeared later in List 2, and 15 were words whose associates appeared in List 2. The remaining five words were filler items, inserted only to increase task difficulty. List 1 was presented twice, each time in a different randomly-determined order, the first of which is shown in Table 1.

The Ss were assigned randomly to one of three List 1 conditions. Under one condition (N=18) the words in List 1 were presented alone at a 5-second rate. In the remaining conditions (Ns=25) each of these words was presented embedded in a meaningful simple sentence. The sentences were presented so that the rate at which the to-be-remembered words occurred was approximately 5-seconds.

The difference between the two sentence conditions was confined to that particular set of 15 words whose associates appeared later in List 2. In one condition the sentences were such that the meaningfulness (although not the precise meaning) of each sentence would be preserved if the associate appearing in List 2 were substituted for the to-be-remembered word. For example, in the case of the to-be-remembered word, HOT, and its associate, COLD, the sentence was "The weather was HOT." In the other sentence condition each of these 15 sentences were such that the substitution of the associate for the to-be-remembered word would result in a marked reduction in meaningfulness, e.g., "The flames were HOT." In these conditions will be referred to as Interchangeable and Non-interchangeable, depending on whether sentence meaningfulness is preserved if the associate is substituted for its corresponding to-be-remembered word. In recording the sentences, the to-be-remembered words were emphasized by being spoken more loudly than others in the sentences. The Ss in these conditions were instructed to listen to each entire sentence, but to focus on and attempt to remember the emphasized words. A subsequent check showed that Ss had no trouble determining which were the to-be-remembered words.

Table 1

Words Used in Experiments Ia and Ib

List 1		List 2			
only	eagle	listen	F	heavy	O
bitter	pretty	lazy	O	scissors	O
torn	book	hair	N	good	N
blossom	down	train	O	afraid	O
bell	door	white	A	green	O
quiet	train	smooth	N	free	N
black	green	torn	O	soft	A
ball	afraid	sweet	A	smart	N
funny	fast	quiet	O	ball	O
bread	carpet	fish	N	paint	N
lazy	scissors	river	N	bird	A
hard	high	cold	A	short	A
heavy	water	high	O	hammer	N
table	dark	light	A	funny	O
late	fell	chair	A	mad	N
dogs	clean	water	O	book	O
tall	hot	butter	A	window	N
broken		paper	N	rug	A
		church	N	cats	A
		ugly	A	king	N
		up	A	flower	A
		box	N	clean	O
		bell	O	slow	A

Note - Abbreviated: F = Filler, O = Old, A = Associates, and N = New.

Immediately following presentation of List 1, the 46 words constituting List 2 were presented at a 5 second rate with Ss instructed to make an old-new decision for each word. List 2 consisted of 15 Old words (words from List 1), 15 Associates (of 15 other words from List 1), and 15 New words (words unrelated to any List 1 words). In addition, one filler item was placed at the beginning of List 2. Each of the Associates was of the same form class as its corresponding List 1 word, and these pairs were selected by use of the Palermo and Jenkins (1964) word-association norms. The Ss indicated their decisions by marking one of four responses, ranging from certainty that the word had appeared on List 1 to certainty that it had not appeared. The List 2 words also are shown in Table 1, in the order (randomly determined) of their appearance.

Results and Discussion

The mean numbers of Old words, Associates, and New words, judged old for each of the three experimental conditions are shown in Table 2. For this purpose the high- and low-confidence judgments of old were combined and treated identically. Under all conditions, old judgments were much more frequent for Old words than for Associates, and were less frequent for the New words, a pattern that has been typical in recognition studies of this sort (e.g., Kimble, 1968). The critical question concerning these particular data relates to the interaction between the experimental conditions and the frequency of false recognitions (Old judgments) to the Associates and New words. Since there were unequal numbers in the three groups, this effect was examined by calculating for each S the difference between Associates and New words in the frequency of false recognitions and applying a one-way analysis of variance to the means of these differences. The three conditions differed reliably in this respect, $F(2,65) = 4.20$, $p < .05$., with the mean of the Associates-New words scores substantially lower for the Non-interchangeable condition than for the remaining conditions. As may be seen in Table 2, this difference is primarily due to a lower frequency of false recognitions of the Associates by the Ss in the Non-interchangeable condition. In fact, the difference between Associates and New words in frequency of false recognitions did not differ reliably within the Non-interchangeable condition, $t(24) = 1.47$, $p > .10$. This reduction presumably reflects a decrease in the occurrence of the Associates as implicit associative responses when the sentence context prohibits the meaningful substitution of the Associate for its corresponding to-be-remembered word. The fact that the error frequencies for the other two conditions were highly similar further suggests that it is not simply the presence of a meaningful context that modifies the occurrence of implicit associative responses but rather the precise nature (semantic, in this case) of the context.

Experiment Ib

In both of the sentence conditions of Experiment Ia the to-be-remembered words were presented in the context of sentences. Experiment Ib was concerned

Table 2

Judgments of "Old" in Experiment Ia as a Function of Presentation Condition and Type of Word

Presentation Condition	Type of Word		
	Repeated	Experimental	Control
Words alone			
Mean	14.00	3.50	1.33
SD	,66	2.69	1.18
Interchangeable			
Mean	11.60	3.40	1.44
SD	2.47	2.35	.81
Non-interchangeable			
Mean	11.80	2.24	1.64
SD	2.12	2.45	2.04

with contextual effects when these key words were first presented alone; and then, in the sentence context. Under such conditions, there would be an opportunity for the "normal" associates to occur as implicit associative responses prior to the occurrence of the potentially constraining context. In fact, Ss could learn the words without attending to the contexts at all. Under such circumstances one would anticipate a marked reduction in the difference between the two sentence conditions. Specifically, it would be predicted that false recognitions would occur more frequently for Associates than for New words under both of the sentence conditions, and that there would be no reliable difference between them in this respect.

Method

The Ss were 27 students again drawn from an introductory psychology course at Northwestern. They were assigned randomly to the two experimental conditions. These conditions were identical in all respects to the two sentence conditions of Experiment I except that immediately prior to presenting each sentence, the to-be-remembered word was presented alone with Ss instructed to attempt to remember these words. There were 14 Ss in the interchangeable condition and 13 in the Non-interchangeable condition.

Results and Discussion

The mean numbers of false recognitions for Experiment II are shown in Table 3. The associates-New words means for the two conditions did not differ, $t(26) < 1.00$, but within each condition the mean of the Associates-New words differences was reliably greater than zero, $t(12) = 2.73$, and $t(13) = 2.89$, $p < .05$. These results are as predicted and suggest that when Ss are able to attend to the to-be-learned word without attending to the context in which that word is placed, the potential contextual effects on encoding may be obscured.

General Discussion

Both experiments were concerned with the encoding of verbal material for memory, and particularly with conditions affecting the occurrence of implicit associative responses assumed to be important in the encoding process. Prior research (e.g., Underwood, 1965; Kimble, 1968) indicated that free association responses are informative as to the nature of the associative processes involved when an individual encodes a word presented alone for learning. The data of Experiment Ia confirm this finding and extend this generalization to the case in which a word is presented in a meaningful context

Table 3

Judgments of "Old" in Experiment Ib as a Function of Presentation Condition and Type of Word

Presentation Condition	Type of Word		
	Repeated	Experimental	Control
Interchangeable			
Mean	11.57	3.36	2.00
SD	3.23	2.66	1.73
Non-interchangeable			
Mean	11.15	3.69	2.00
SD	2.09	2.37	1.66

where the substitution of the associate for the to-be-remembered word preserves the meaningfulness of the sentence. Under this condition the frequency of false recognitions produced by implicit associative responses was nearly as great as for the words-alone condition. Note that this was true even though the substitution of the associate for the to-be-remembered word did, in every case, alter considerably the meaning of the sentence, i.e., the two words were not synonyms. However, when sentences were constructed so that a meaningful interchange of the to-be-remembered words and their associates was not possible, there was no evidence that the associates occurred as implicit associative responses. In other words, the nature of associative encoding was modified under these conditions. The data not informative as to the precise nature of that modification.

Experiment Ib was suggested by the results of a pilot study conducted prior to Experiment Ia. That pilot study was essentially identical to Experiment Ia, except that all material was presented visually, and the to-be-remembered items embedded in sentences were underlined. In that study it was clear that no differences were emerging between the two sentence conditions. A probably explanation of these negative results was that with the visual presentation Ss could simply focus entirely on the underlined words and not attend to the contexts. Thus, the aural procedure of Experiment Ia was employed and the predicted results were obtained. In Experiment Ib it again was possible to ignore the sentence contexts during learning, since each to-be-learned word was pronounced alone immediately prior to its presentation within the sentence. As with the pilot research, there was no apparent experimental effect, suggesting that the mere presence of the context is of minor importance in the absence of some procedure that ensures attention to that context, prior to an opportunity for the occurrence of implicit associative responses.

A number of important questions remain. As mentioned above, although the experimental manipulations in these experiments demonstrated the context-produced modifiability of associative encoding processes, they did not clarify the nature of that modifcation. Moreover, they were confined to certain semantic characteristics. To what extent syntactic factors are of importance is not clear. For example, the most common word-association response of college students to QUICKLY (an adverb) is FAST (an adjective). Suppose that QUICKLY were embedded in a sentence such that only an adverb would fit syntactically in its place in the sentence. Would such syntactic characteristics modify the encoding process so that FAST would not occur as an implicit associative response? Or, would semantic factors perhaps override the syntactic ones? The false recognition technique appears to offer some promise for attacks on such questions.

EXPERIMENT II: FALSE RECOGNITIONS AS A FUNCTION OF NUMBER OF PRESENTATIONS*

In earlier papers it was suggested that the perceived situational frequency of words presented for recognition is a critical cue for recognition decisions (Hall, 1969; Hall, Sekuler and Cushman, 1969). This assumes, as proposed by Ekstrand, Wallace, and Underwood (1966), that the frequency with which a word occurs is recorded in some manner. The perceived situational frequency of a word presented for recognition is a function of the number of prior presentations of the word (perceptions of the word by the S) plus the number of implicit occurrences of the word, as a result, for example, of rehearsal of the words. Thus, situational frequency-counts above zero exist either when a word was previously presented or when it occurred solely as an IAR to a presented word. Presumably the count would be higher for an actually presented word since such a word normally is perceived by a S, pronounced implicitly, and perhaps rehearsed. One would expect less attention to be given to any particular IAR.

Hall, Sekuler, and Cushman (1969) proposed a model to account for performance when words presented for recognition fall into one of three classes: words presented earlier ("old" words), "new" words that are strong associates of previously presented words, and new words unrelated to presented words. According to this model, the S establishes a perceived situational frequency criterion against which words are judged when recognition decisions are required. That is, words whose perceived situational frequency exceed that criterion are judged "old" and those that do not are judged "new". Also, the further above the criterion the greater the confidence and the speed with which the "old" judgment is given.

The above analysis leads to a clear-cut prediction relative to the relationship between the number of occurrences of a word and the probability that the word will be judged "old" when it is presented for recognition. First, the greater the number of presentations of a word, other things equal, the greater the probability of that word subsequently being correctly judged "old". Second, the greater the number of presentations of a word that consistently elicits a particular associate as an IAR the greater the probability of that associate being incorrectly judged "old". The validity of the first of these two hypotheses needs no additional documentation. It is the second of these with which the present experiment is concerned. Some evidence relevant to this prediction comes from an experiment by Underwood (1965) in which a set of words was presented either one or three times prior to presentation of strong associates of these words. False recognitions of the associates were more frequent for the three-presentation than for the single-presentation condition. Such a difference seems reasonable in that one would not expect any word to elicit the same IAR for all Ss upon the first presentation. However, a second and third presentation might well result in nearly 100 percent

* The results of this experiment are described in an article of the same title by James W. Hall and Edward E. Kozloff, in press in the American Journal of Psychology.

occurrence of strong associates as IARs, thus providing increasing basis for subsequent false recognitions. In contrast, the prediction following from the Hall, Sekuler, and Cushman (1969) analysis is that with increasing numbers of occurrences as IARs of a set of words the perceived situational frequencies of those words eventually would be shifted upward to the point where all would be falsely recognized, a possibility that appeared intuitively unlikely.

The above prediction was tested in the experiment reported here by presenting a set of words either one, three, five, or seven times (within-Ss) prior to the presentation of the associates of these words. Recognition performance for these conditions and for repeated and control words then was examined.

Method

Subjects: Ss were 160 students enrolled in an introductory psychology course at Northwestern University.

Design and Procedure: A single word-list of 99 items was presented to the Ss. The first 66 items in the list consisted of 7 filler (F) words, 9 repeated (R) words, and 12 critical stimulus (CS) words. The F words were inserted to increase both the difficulty and face validity of the task. The R words were items which were repeated among the final 33 words in the list. Each of the 12 CS words was assumed, on the basis of normative word association data, to elicit a particular response as an IAR with relatively high frequency. The CS words were divided into four groups of three words each. One group occurred once (CS1), and one group occurred three times (CS3), one group occurred five times (CS5), and the remaining group seven times (CS7). Thus, there were four conditions based on the number of presentations of CS words. A counterbalancing procedure was employed so that each group of three CS words occurred under each condition, resulting in four different forms of the list with one-fourth of the Ss randomly assigned to each form.

The remaining 33 words were exactly the same for all lists. In addition to the nine R words were 12 experimental (E) words and 12 control (C) words. The 12 E words were strong natural language associates of the 12 CS words that had occurred previously. These words are designated E1, E3, E5, or E7, depending on the number of prior presentations of the CS words presumed to elicit them. The CS-E pairs were selected on the basis of published word association data (Palermo and Jenkins, 1964). The C words were approximately equivalent to the E words in general frequency of occurrence according to the Thorndike and Lorge (1944) norms, but were not strong associates of any other words in the list. One form of the list and the function of each word are shown in Table 4.

The lists were presented visually by means of a slide projector to groups of from four to eight Ss. The presentation rate was 2.5 seconds per word. The Ss were instructed to indicate "yes" on an answer sheet if a word had occurred earlier in the list and "no" if it had not. Only responses

Table 4

Word List for Experiment II and Function of Each Item

king	CS	hard	CS	train	R
on	CS	brush	R	fast	E
lamp	CS	slow	CS	bath	C
hand	R	butter	CS	brush	R
on	CS	king	CS	flower	E
mountain	F	city	R	shoe	C
king	CS	news	R	wild	R
lamp	CS	slow	CS	quiet	R
month	F	hard	CS	soft	E
blossom	CS	lamp	CS	rough	C
on	CS	hammer	CS	bread	E
lamp	CS	butter	CS	sleep	E
slow	CS	quiet	R	old	E
hammer	CS	on	CS	whiskey	C
king	CS	blossom	CS	pretty	C
door	F	king	CS	cut	E
friend	R	table	CS	between	C
hand	R	music	R	wing	C
train	R	scissors	CS	hand	R
lamp	CS	table	CS	light	E
slow	CS	blossom	CS	news	R
blossom	CS	on	CS	hat	C
wild	R	king	CS	name	C
on	CS	slow	CS	cow	C
king	CS	butter	CS	city	R
hammer	CS	young	CS	clear	C
clock	F	spider	F	chair	E
friend	R	bed	CS	nail	E
table	CS	hard	CS	music	R
hammer	CS	hammer	CS	queen	E
on	CS	lamp	CS	actor	C
lamp	CS	sad	F	friend	R
blossom	CS	apple	F	off	E

Note. - Abbreviated: F = filler, CS = critical stimulus, R = repeated, E = experimental, and C = control.

to the final 33 were relevant to the purposes of the experiment, so only those items were scored and included in the results.

Results

The mean percentages of "old" responses were 82.8 for the R words, 7.5 for the E words (combining the four conditions), and 2.7 for the C words. The mean percentages of false recognitions for the various categories of E words and for the C words are shown in Fig. 1. The frequency of false recognitions increased sharply (from one to three presentations of the CS words) then fell off with additional presentations, and the difference among the four E - word means was reliable, F (3,636) = 3.09, $p < .05$. The overall differences between E and C words in frequency of false recognitions was highly reliable, t (159) = 6.88, $p < .01$. Even in the case of E7 words the proportion of false recognitions was reliably greater than for the C words, t (159) = 3.98, $p < .01$. For the latter test the difference in mean proportion of false recognitions was obtained by multiplying the mean number of false recognitions of E7 words by four, then subtracting the mean number of false recognitions of the C words. The error term employed was that used in testing the overall difference between E and C words.

Discussion

In an earlier paper, (Hall, Sekuler, and Cushman, 1969), it was suggested that Ss make their recognition decisions on the basis of the perceived frequency criterion set by the Ss. On the average, the perceived frequency of R words would be higher than that for E and C words because every R word had been presented to every S earlier. The distribution of E words in terms of perceived frequency would be higher than for C words because of the prior occurrence of E words as IARs, but not as high as for R words since it is assumed that not all E words do occur as IARs for all Ss. This analysis is consistent with the differences in frequency of "old" responses for the C, E1, E3, and R words in the present experiment. In particular it predicts the observed higher frequency of false recognitions of E3 than of E1 words, assuming that the two additional occurrences of the CS3 words resulted in the occurrence as IARs of an increasing number of the E3 words, these then being shifted upward in perceived frequency past the perceived frequency criterion. However, according to this analysis, the perceived frequency of E5 and E7 words, and thus the frequency of "old" responses, would be even greater rather than less, as was found. In other words, this recognition performance model simply fails to account for a substantial portion of the results in this experiment. Rather than discarding the model completely at this point, the authors are led to the following modification of it.

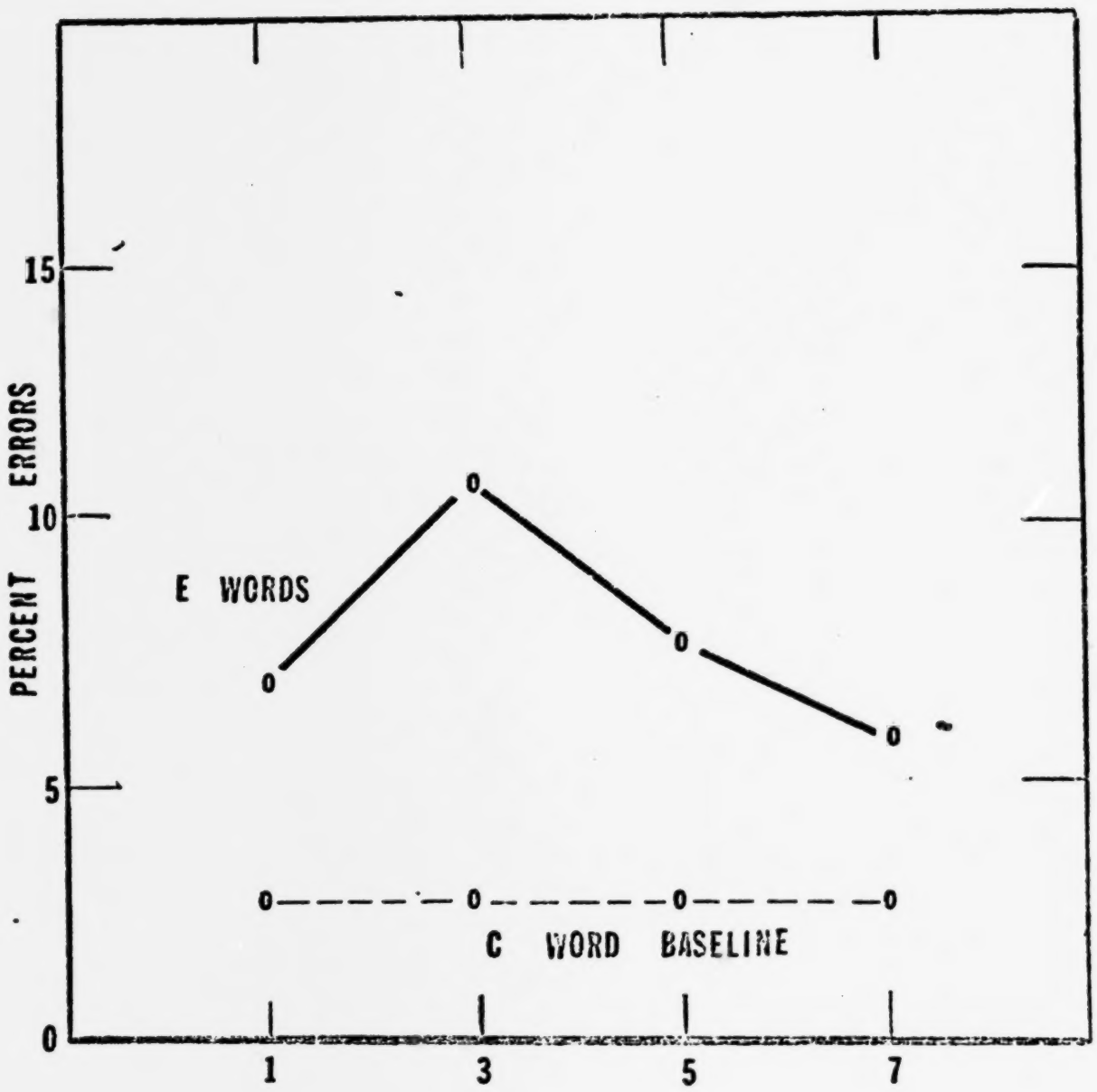

Figure 1. Percent of false recognitions of E and C words.

A two-stage recognition model is proposed in which stage one consists of a comparison of the perceived situational frequency of the word with the Ss perceived situational frequency criterion, as in the earlier analysis. When a word falls below that criterion, as in the case of nearly all C words, it is judged "new" and the S moves to the next item. A substantial number of E words, particularly if the corresponding CS words have been presented only once, are immediately judged "new" in this fashion. However, many of the E words have occurred earlier as IARs so register above the Ss frequency criterion. We propose that such prior occurrence of E words is a necessary but insufficient condition for their false recognition, because in most such cases Ss are able to avoid the incorrect judgment "old" through a second comparison. It seems reasonable to assume that IARs occur during recognition just as they do earlier, and that the word most likely to occur as an IAR is the CS word which previously elicited the E word as an IAR. In other terms, the E words "remind" the S of the CS words presented earlier. This is particularly probable in the case of such bidirectional associates as TABLE-CHAIR and pairs of polar adjectives. This appears likely even with such unidirectional associates as SCISSORS-CUT and BLOSSOM-FLOWER where the response word ordinarily would not elicit the stimulus word on a word-association test. That is, the prior occurrence of the CS word ought to prime its subsequent occurrence as an IAR. The priming effect would be particularly powerful where the CS word had occurred a number of times previously as with the CS5 and CS7 words in the present experiments. Moreover, if the E word had been elicited as an IAR by the CS word earlier, then through backward associations the probability of the CS word occurring as an IAR when the E word is presented for recognition is increased.

Once the S is reminded in the above fashion of the CS word, the decision as to which of the two words really did occur earlier can be analyzed as a verbal discrimination problem and the frequency theory proposed by Ekstrand, Wallace, and Underwood (1966) can be applied. This theory states that the major cue for discrimination is a disparity in perceived situational frequency difference between CS words and whatever words occur as IARs is presumed due to the Ss relatively greater attention to and implicit rehearsal of any word actually presented. This disparity would increased as the number of presentations of a given CS word increases. It is primarily this disparity in perceived situational frequency between a CS word and its corresponding E word that allows the S to generally select the CS word and avoid false recognition of the E word. The fact that IAR false recognitions do occur in some instances may be due either to the failure of the CS word to come to mind when the E word is presented or to insufficient difference in perceived situational frequency between the two. The probabilities of both of these events are decreased as the number of occurrences of the CS word is increased.

The notion that Ss discriminate between E and SC words on the basis of the difference between them in perceived situational frequency leads to a rather clear-cut prediction. Suppose that through word association testing one identifies three words not strongly associated with one another but each of which elicits thesame word as a strong associate. For example,

LAMP, HEAVY, AND DARK each elicit LIGHT with high frequency but are very weakly associated with one another. Suppose further that under one condition Ss are presented with only one of these three words, but that word occurs three times in the list, whereas the remaining Ss are presented each of the three words a single time. In the first instance, each time a "frequency count" is added to the E word (LIGHT in this case) an even greater frequency count is added to the CS word (e.g., LAMP). Thus, a basis for discrimination between the E and CS words in terms of the discrepancy in perceived situational frequency is developed. In the second instance, where converging associations are involved, there is no build-up in the frequency differences with additional occurrences of the E word because it is a different CS word that occurs each time. Thus, one would predict more difficult discrimination and a correspondingly higher frequency of false recognitions in the case of converging associates.

EXPERIMENT III: A DEVELOPMENTAL STUDY OF THE EFFECTS OF FOUR LEVELS OF PROBLEM KNOWLEDGE ON FREQUENCY OF SUBSEQUENT IAR-PRODUCED FALSE RECOGNITIONS

In a recent experiment (Hall, 1969b), data were obtained which suggest that the specific nature of the learning instructions for List 1 is of some importance in determining the frequency of subsequent IAR-produced false recognitions. Within each of two age levels (five- and six-year olds and eight- and nine-year olds) Ss were randomly assigned to three groups which varied only in terms of the design and procedures were the same as in earlier experiments already described. At each age level one-third of the Ss received instructions designed to facilitate the occurrence of IARs during learning, and thus to increase the frequency of IAR-produced false recognitions. This facilitation group was told that to help in remembering the words they should think of words of which the stimulus words remind them. A second group, the restriction group, was told that as soon as they hear a word they should say the word over and over to themselves and not think of anything else until the next word is presented. A third group received the usual instructions to try to remember the words, but with no directions about how to do so. The effect of instructions was reliable, with the highest frequency of IAR-produced false recognitions for the facilitative group and the lowest for the restriction group. Age was unrelated to this effect.

The experimental results just described indicate that the frequency of word recognition errors due to the occurrence of IARs can be reduced or increased by the imposition of certain learning strategies on the child. An interesting question that is not answered is the extent to which the child will adopt error-reducing strategies by himself when he has foreknowledge of the nature of the recognition task which he will face. This is the question of concern in Experiment II. Four groups of children, at each of two age levels, varied only in the degree to which they were informed of the specific nature of the task. No particular learning strategies were imposed by the experimenter. One group was told only that they should try to learn the words in List 1. The second group was informed, in addition, that a second list of words will be presented later and that the task will be to recognize words on List 2 that had appeared earlier on List 1. Ss in the third and fourth groups received a brief explanation regarding the phenomenon of IAR-produced false recognitions in addition to the information given the other two groups. The difference between these latter two conditions was that one group received this explanation prior to the presentation of List 1, whereas the remaining group was given the explanation after List 1 had been presented but immediately prior to the presentation of List 2 (the recognition list). This was done in an attempt to localize whatever effects of the explanation might be found.

Method

Subjects. The Ss were 100 third-grade and 100 fifth-grade children enrolled in public elementary schools in Wilmette, Illinois, a predominantly middle-class suburb of Chicago immediately north of Evanston. Thus, these Ss were highly homogeneous in socio-economic backgrounds.

Design and Procedure. As in the other experiments, the design called for the successive presentation of two lists of words. The 36 words of List 1 and the 48 words of List 2 are shown in Table 5 , along with the function of the List 2 words. List 2 consisted of 16 Old words (words also on List 1), 16 Associates (words strongly associated with 16 of the words in List 1), and 16 New words (words unrelated to any words in List 1). Except for the placement of two filler words at the beginning and two at the end of List 1, the order of the words in both lists was determined randomly. The words were presented by use of a tape recorder at a 4-second rate for List 1 and a 6-sec rate for List 2. List 1 was presented twice in its entirety.

There were four experimental conditions in terms of the instructions and explanations given the Ss. The Ss in Group I were told, prior to List 1 presentation, that a series of words would be read to them and that they should try to remember the words. Immediately before presentation of List 2 they were told that a second list would be presented and that they were to decide for each word whether it was "old" or "new." Group II was given identical instructions except that they were told at the time of List 1 presentation that a second list would be presented for recognition. That is, they were told of the basic nature of the test - that it involved recognition rather than recall-before the to-be-learned words were presented. The Ss in Group III were given these same (as Group II) instructions, but in addition their List 1 instructions included an explanation of the phenomenon of IAR-produced false recognitions, along with an example of how such "confusions" might occur. For Group IV the same instructions and explanation were given, except that the explanation of IAR-produced false recognitions occurred after List 1 presentation, so that any effects of the additional explanation would be confined to the recognition phase.

At each grade level the 100 Ss were assigned to the four conditions at random except to insure an N of 25 per condition.

Results and Discussion. Analyses of variance were performed with respect to frequency of "old" judgements to Old and to New words, and with respect to the difference scores (Old - New). In none of these three analyses did the main effect of Grade Level or Instructions, or the interaction between these variables, approach significance. That is, the variations introduced in terms of degree of advance knowledge regarding the experimental task had no apparent affect of recognition performance when the usual indexes of that performance were examined. Nor did performance vary reliably with age. In fact, since none of the analyses performed

Table 5

Word Lists for Experiment III

List 1		List 2			
listen	grass	doctor	O	street	O
picture	hard	top	N	coat	O
fast	pretty	surprise	O	church	N
ocean	hot	train	O	bird	A
table	kittens	ocean	O	ugly	A
you	bed	gallup	N	love	O
street	mountain	hammer	N	flower	A
eagle	carpet	bring	N	book	O
dark	angry	slow	A	mad	A
surprise	doctor	sleep	A	grass	O
love	afraid	good	N	smart	N
coat	pepper	door	O	chair	A
baby	tree	me	A	baby	O
blossom	tobacco	cut	A	window	N
tall		candy	N	soft	A
book		free	N	pepper	O
old		queen	A	cottage	O
door		short	A	never	N
scissors		time	N	light	A
king		cold	A	music	N
train		hair	N	rug	A
cottage		mountain	O	kittens	O
		old	O	smooth	N
		fish	N	scared	A

Note. - Abbreviations: A = Associates;
N = New Words; O = Old Words.

showed reliable age differences, nor any significant interactions involving Grade Level, the recognition performance data are collapsed over age for their presentation in Table 6.

A somewhat different picture emerged when performance on Associates was examined. Here the effect of Instructions was significant, $F(3,192) = 4.34$, $p < .01$. Neither Grade Level nor the interaction between Grade Level and Instructions produced effects that approached significance. From an examination of Table 6, it is apparent that the significant effect of Instructions reflects a higher frequency of false recognitions of Associates by Ss in Groups I and II as compared with those in Groups III and IV. Similar results emerge when the analysis is applied to the Associate-New word difference scores, $F(3,192) = 3.94$, $p < .01$. Clearly, information regarding the nature of IAR-produced false recognitions resulted in a reduction of such errors. Moreover, this reduction was just as great when that information was withheld until after the to-be-remembered words were encoded as it was when Ss were given the information prior to encoding. In other words it might conclude that such advance information has no substantial effect of encoding behavior, but does affect the recognition-decision process. The nature of such an effect is not clear, but the data suggest that it is not simply a case of Ss raising their criterion for judgements of "old," since if that were the case, the frequencies of such judgements of Old and New words ought to be substantially lower for Groups III and IV than for Groups I and II. In fact, such a difference did not occur. It remains for further investigations to clarify the nature of these effects.

Table 6

Mean Number of "Old" Judgments to Each Type of Word by Ss in Each Condition

Condition	Type of Word		
	Old words	Associates	New words
I	12.92	2.40	1.18
II	13.16	3.42	1.96
III	13.26	2.30	1.72
IV	12.52	1.98	1.32

EXPERIMENT IV: EFFECTS OF INSTRUCTIONS TO PRONOUNCE ON THE RECOGNITION PERFORMANCE OF CHILDREN AT THREE AGE LEVELS

Recently it was shown that when kindergarteners overtly pronounced to-be-learned words, their subsequent recognition performance was superior to subjects (Ss) who had not pronounced the words (Hall, 1968). No such difference was found for third-grade Ss. However, the recognition performance level of Ss who did not pronounce overtly during learning was at so high a level as to possibly obscure any facilitative effects of pronouncing. That is, the lack of a reliable treatment effect for the third graders may have been due to a ceiling effect. A plausible alternative hypothesis that is more interesting, is that the older Ss (but not the younger ones) were regularly pronouncing the words covertly in the absence of specific instructions, and that this strategy was about as effective as the overt pronouncing strategy imposed by the experimenter. The present study was designed to test that hypothesis and to provide additional information regarding the effects of instructions to pronounce covertly on the recognition performance of children from five to ten years of age. It was predicted that the facilitative effects of instructions to pronounce overtly would be relatively great for the youngest Ss and relatively little for the older ones. Expectations regarding the effectiveness of covert pronunciation instructions were less clear.

An additional purpose of the study concerns the tendency of Ss to falsely recognize words that are strongly associated with words actually presented. This is, the presentation of the word "blossom" increases the likelihood of Ss subsequently falsely recognizing the word "flower." This phenomenon has been reported both for adults (e.g., Underwood, 1965) and for children (e.g., Hall and Ware, 1968). The term "IAR-produced false recognitions" has been applied to such errors in that it has been proposed that they result from the occurrence of strong associates as "implicit associative responses" to a presented word. That is, for example, when "blossom" is presented, "flower" is likely to occur as an IAR, increasing the probability that it will be falsely recognized subsequently. In the present study such errors are examined in relation to the variations in learning instructions and age.

Method

Subjects. Thirty-six Ss had just completed the 4th grade, 36 had completed grade 2, and 31 had completed kindergarten. These Ss were enrolled in a summer program in a public elementary school in Evanston, Illinois. Five additional children who had just entered grade 1 in the same school were added to the kindergarten group, bringing the total Ss to 36 at each age level. The Ss were selected randomly from their respective grade levels. They were heterogeneous in terms of socio-economic backgrounds, with a majority apparently quite low in that respect.

Design and procedure. A list of 32 words to be remembered was presented to each S at a 4-second rate. After approximately 1 min., a second list of 38 words was presented at a 5-sec. rate, and S was instructed to identify each word that also had appeared on List 1. Both lists, as well as instructions, were presented auditorily using a tape recorder. The words are shown in Table 7.

List 2 included words that also had appeared on List 1, termed old words. Also included were new words that were not in List 1 and were not strong associates of any List 1 words. A third category of List 2 words consisted of any List 1 words. A third category of List 2 words consisted of strong associates of certain List 1 words as determined by recently published word association norms (Entwisle, 1966; Palermo and Jenkins, 1966), and the List 1 words of which they are associates were labeled Critical Stimulus words. There were 12 words in each of the above categories. In addition, eight "filler" words were included in List 1 and two in List 2.

At each age level, Ss were assigned randomly to receive one of three types of learning instructions for List 1. Under the Overt Pronunciation condition (Cond. OP) Ss were instructed to repeat each word aloud as it was presented. A second group (Cond. CP) was told to say the words to themselves (covert pronunciation) and for the remaining Ss no mention was made of pronouncing (Cond. NP). Care was taken to ensure that the CP group understood the instructions, i.e., the experimenter elaborated on the instructions if S appeared uncertain as to what was meant. All Ss were instructed to pay close attention to the List 1 words so that they would be able to recognize these words if they heard them again.

Results and Discussion. Recognition performance is summarized in Table 8 . Of primary interest was performance on the old words, particularly in relation to performance on the new words, i.e., true positives in relation to false positives. An analysis of variance for the old words alone indicated no significant effects. Similar results were obtained in terms of performance on the new words considered alone. However, when different scores (old-new) were subjected to an analysis of variance, a reliable effect of Instructions was found, F (2,90) = 3.48, $p < .05$. Clearly this is a result of superior performance on the part of Ss who received instructions to pronounce overtly in relation to the remaining two conditions (see Table 8). Neither the main effect of Age nor the interaction between Age and Instructions was significant (Fs < 1.00).

In this writer's previous study of pronouncing effects, an interaction between age and pronouncing instructions was found. That is, overt pronunciation (vs. no pronouncing instructions) faciliated recognition performance for kindergarteners but not for fourth graders (Hall, 1968). However, it was recognized that this interaction may have been a spurious one due to a possible ceiling effect. In the present experiment the problem of a ceiling effect was avoided, with the result that overt pronunciation was superior to either covery pronunciation or no pronouncing instructions, independent of grade level (age). Thus, it appears that insofar as recognition performance is concerned, overt rehearsal of words results in more effective learning than do whatever strategies

Table 7

Word Lists for Experiment IV

List 1				List 2			
tobacco	O	gallup	CS	smart	F	coffee	N
stem	CS	moon	F	gun	F	church	O
spider	CS	number	F	water	A	pciture	O
king	F	fingers	O	lazy	O	pepper	A
machine	F	table	CS	carry	O	girl	O
bed	CS	salt	CS	take	N	music	N
thirsty	CS	strong	O	tiger	O	light	A
carry	O			fingers	A	book	O
cold	CS			web	N	money	O
money	O			baby	A	is	A
yellow	F			sleep	A	slide	N
picture	O			fly	N	tobacco	O
lamp	CS			street	N	short	N
hammer	F			window	A		
it	CS			hot	N		
doctor	F			play	A		
book	O			cut	A		
ball	O			horse	A		
church	O			strong	O		
lazy	O			flower	A		
bird	CS			train	O		
scissors	O			in	N		
train	O			mountain	N		
listen	F			ball	O		
girl	O			chain	A		

Table 8

Mean Judgments of "Old" in Experiment IV as a Function of Grade Level and Instruction

Grade Level	Overt Pronunciation			Covert Pronunciation			No Pronouncing Instr.		
	O	A	N	O	A	N	O	A	N
K	8.82	.64	.54	7.64	2.27	1.00	7.64	.82	.27
2	8.82	1.18	.91	8.27	1.82	1.46	8.27	1.09	1.82
4	8.64	1.46	.72	8.36	1.09	.64	8.45	2.55	1.73

are employed by students when left on their own, and that this is true for children as old as 10 or 11 years.

The second point of interest in this experiment concerned recognition performance on Associates compared with new words. Previous studies lead to the expectancy of a higher frequency of false recognitions of Associates than of new words, and the further prediction that these differences would be greater for the NP than for the OP condition and for the younger than for the older Ss (Hall, 1968). Unfortunately, there was no reliable overall difference between the Associates and the new words, in frequency of false recognitions. The mean frequencies of false recognitions were 1.52 for the Associates and 1.06 for the new words. The mean difference of .44 (SD = 1.65) did not approach significance, $t(98) < 1.00$. Thus, it was not meaningful to test the additional predictions regarding effects of Age and Instructions. Efforts currently are being made to identify the procedural deficiencies that resulted in this inadeuqate sensitivity with repect to IAR-produced false recognitions.

CONCLUSIONS

Four experiments have been described in this report. Experiments I, II, and IV examine variables that may influence the frequency and nature of IARs in an attempt to clarify the role of IARs in learning and retention. Experiment III explored the effects of instructions to pronounce words during learning on subsequent recognition performance.

In Experiment Ia, 35 words were presented either singly or in one of two sentence conditions. In one sentence condition either the to-be-remembered word or its most common associate (according to word association norms) fit sensibly within the sentence. In the other condition the to-be-remembered words fit sensibly but the associates do not. Subsequent false recognitions of these associates were less frequent in the latter condition than in the words - alone or in the first sentence condition. This difference between the two sentence conditions did not occur when, as in Experiment Ib, each to-be-remembered word was presented alone immediately prior to its presentation in the sentence. The results were interpreted in terms of the modification of associative encoding processes as a result of particular variations in the semantic context of a to-be-remembered word. The precise nature of such modification remains to be explored in subsequent studies.

In Experiment II, a list of words was presented visually to 160 college students. The Ss were asked to indicate for each word whether or not it had appeared earlier on the list. Late in the list were associates of words that had appeared earlier either one, three, five, or seven times. The frequency of false recognitions of the associates first increased, then declined, as a function of the number of times their corresponding CS words had occurred, and was greater than that for nonassociates of previously appearing words. These results were considered in terms of a two-stage recognition model wherein the perceived situational frequency of a word is critical in the recognition decision. Preliminary analyses of data recently obtained lends support to major elements of the proposed model.

Experiment III was concerned with children's adoption of error-reducing strategies in a recognition task when they have foreknowledge of the nature of that task. Information regarding the nature of IAR-produced false recognitions resulted in a reduction of such errors. That reduction was as great when the information was withheld until after the learning stage as it was when given prior to learning, suggesting that such advance information has little or no effect on encoding, but does affect the recognition-decision process.

The purpose of Experiment IV was to examine word recognition performance as a function of age and learning instructions with respect to pronunciation. Recognition performance was best when Ss had overtly pronounced the to-be-remembered words, and equal under conditions of covert pronouncing and no instructions to pronounce. No other differences were significant.

REFERENCES

Bousfield, W. A., Whitmarsh, G. A., and Danick, J. J. Partial response identities in verbal generalization. Psychological Reports, 1958, 4, 703-713.

Ekstrand, B. R., Wallace, W. P., and Underwood, B. J. A frequency theory of verbal discrimination learning. Psychological Review, 1966, 73 566-578.

Hall, J. W., Effects of three variations in learning instructions on children's word recognition performance. Journal of Educational Psychology, 1969, 60, 461-464.

Hall, J. W., Errors in word recognition and discrimination by children of two age levels. Journal of Educational Psychology, 1969, 60, 144-147.

Hall, J. W., Word recognition by children of two age levels. Journal of Educational Psychology, 1968, 59, 420-424.

Hall, J. W., Sekuler, R., and Cushman, W., Effects of IAR occurrence during on response time during subsequent recognition. Journal of Experimental Psychology, 1969, 79, 39-42.

Hall, J. W., and Ware, W. B., False recognition in children produced by implicit associative responses. Journal of Experimental Child Psychology, 1968, 6, 52-60.

Kimble, G. A., Mediating associations. Journal of Experimental Psychology, 1968, 76, 263-166.

Palermo, D. S., and Jenkins, J. J. Word association norms grade school through college. Minneapolis: University of Minnesota Press, 1964.

Thorndike, E. L., and Lorge, I., The teacher's word book of 30,000 words. New York: Teachers College, Columbia University, 1944.

Underwood, B. J., Attributes of memory. Psychological Review, 1969, 76 559-573.

Underwood, B. J., False recognition produced by implicit verbal responses. Journal of Experimental Psychology, 1965, 70, 122-129.